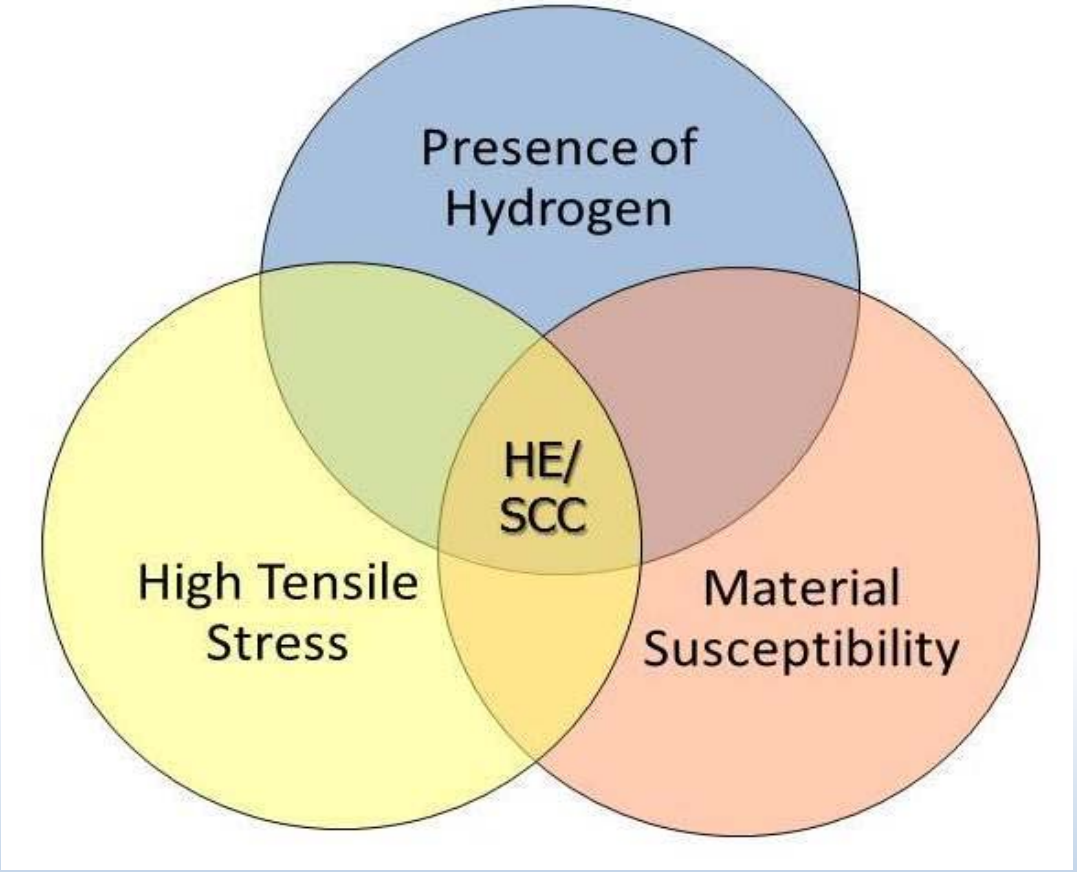
Briefing on Bay Bridge Bolts – July 10, 2013

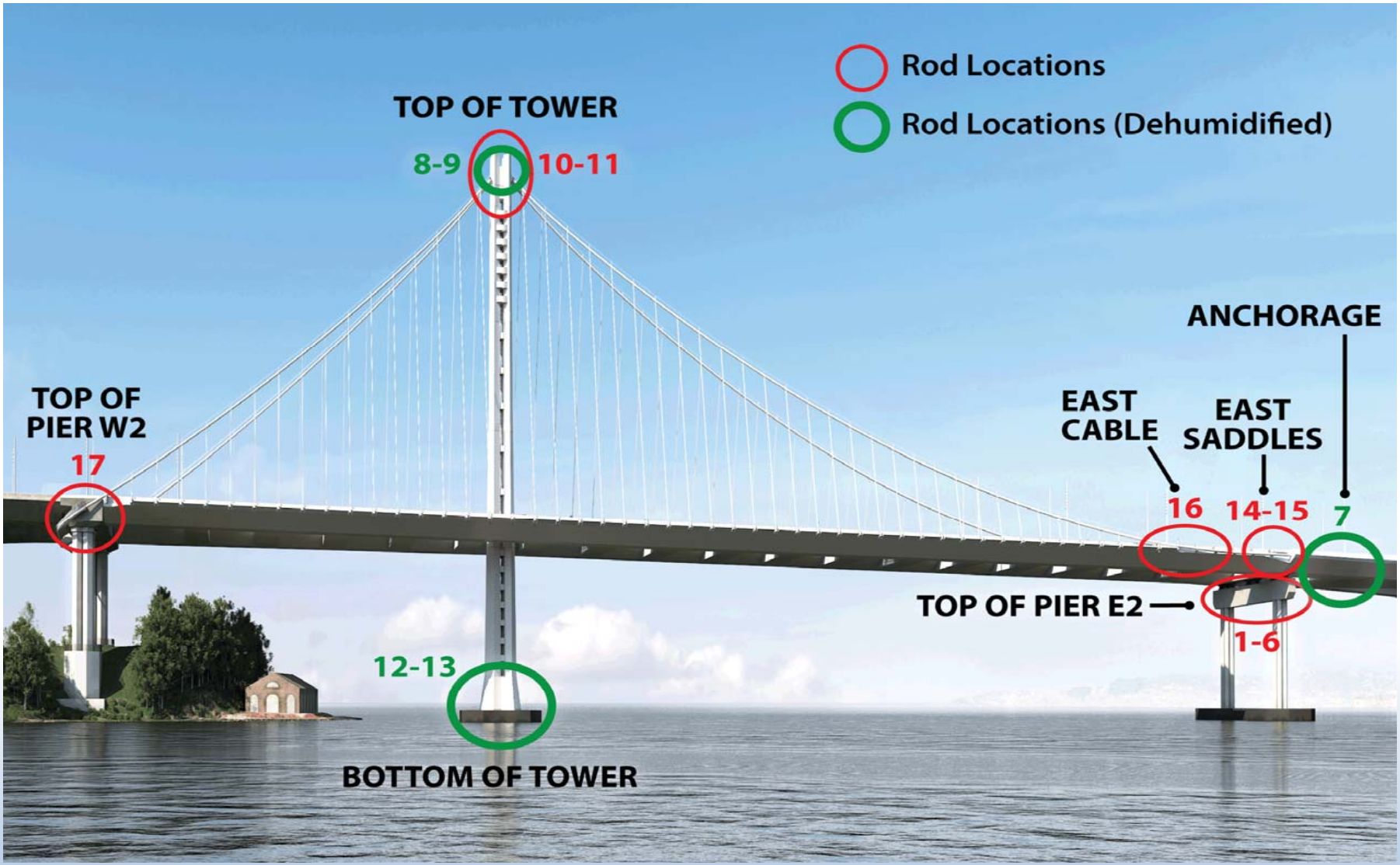
Items Expected at July 10 BATA Briefing

- Completion of written TBPOC investigative report, plus
- Firm schedule for E2 2008 bolt retrofit, plus
- Decision on other bolts on SAS, equals
- Decision on Seismic Safety Opening Date of Bay Bridge.

Causes of Hydrogen Embrittlement (HE) or Stress Corrosion Cracking (SCC)



A354 Grade BD Rod Locations on the SAS Bridge

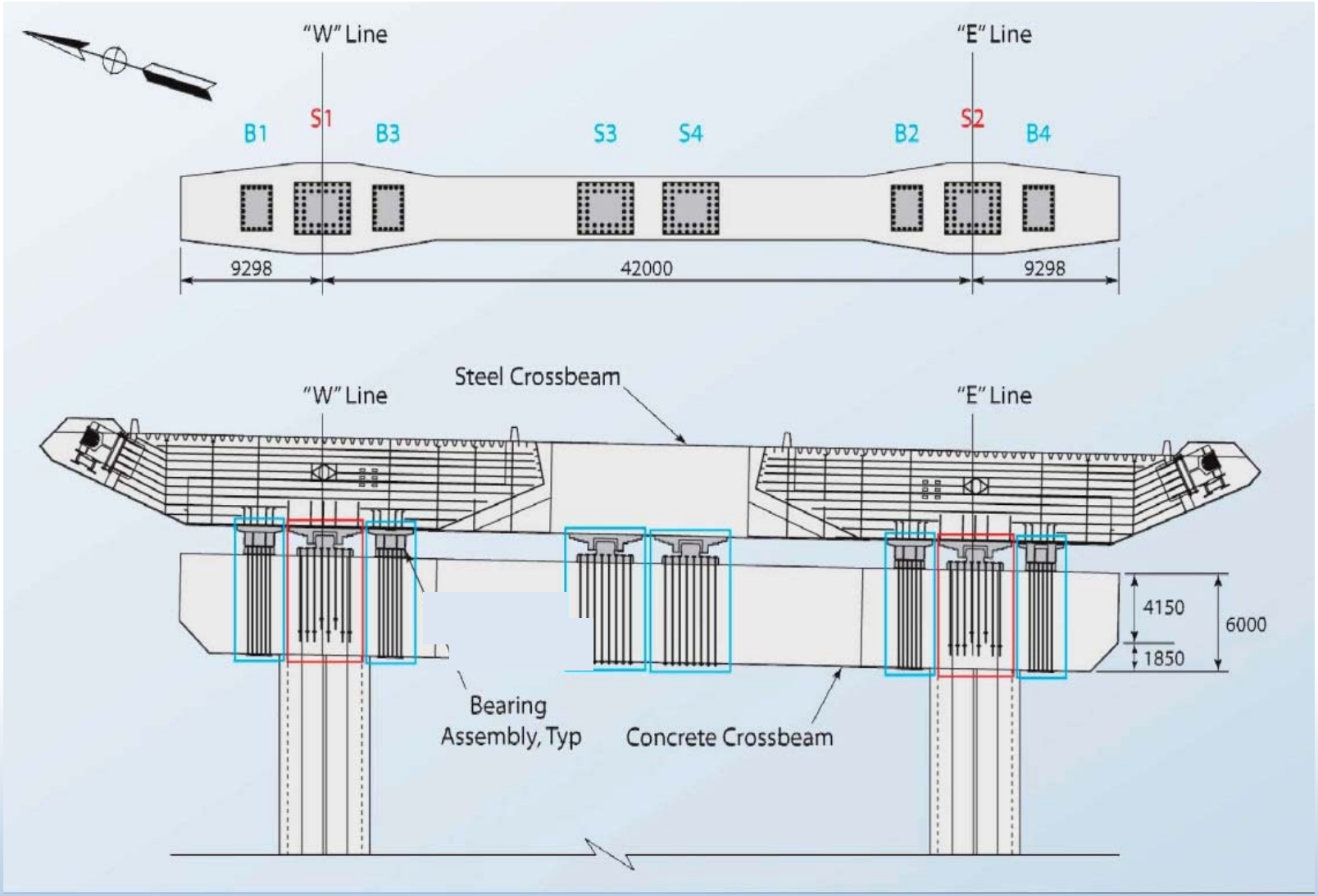


A354 Grade BD Rods on the SAS Bridge

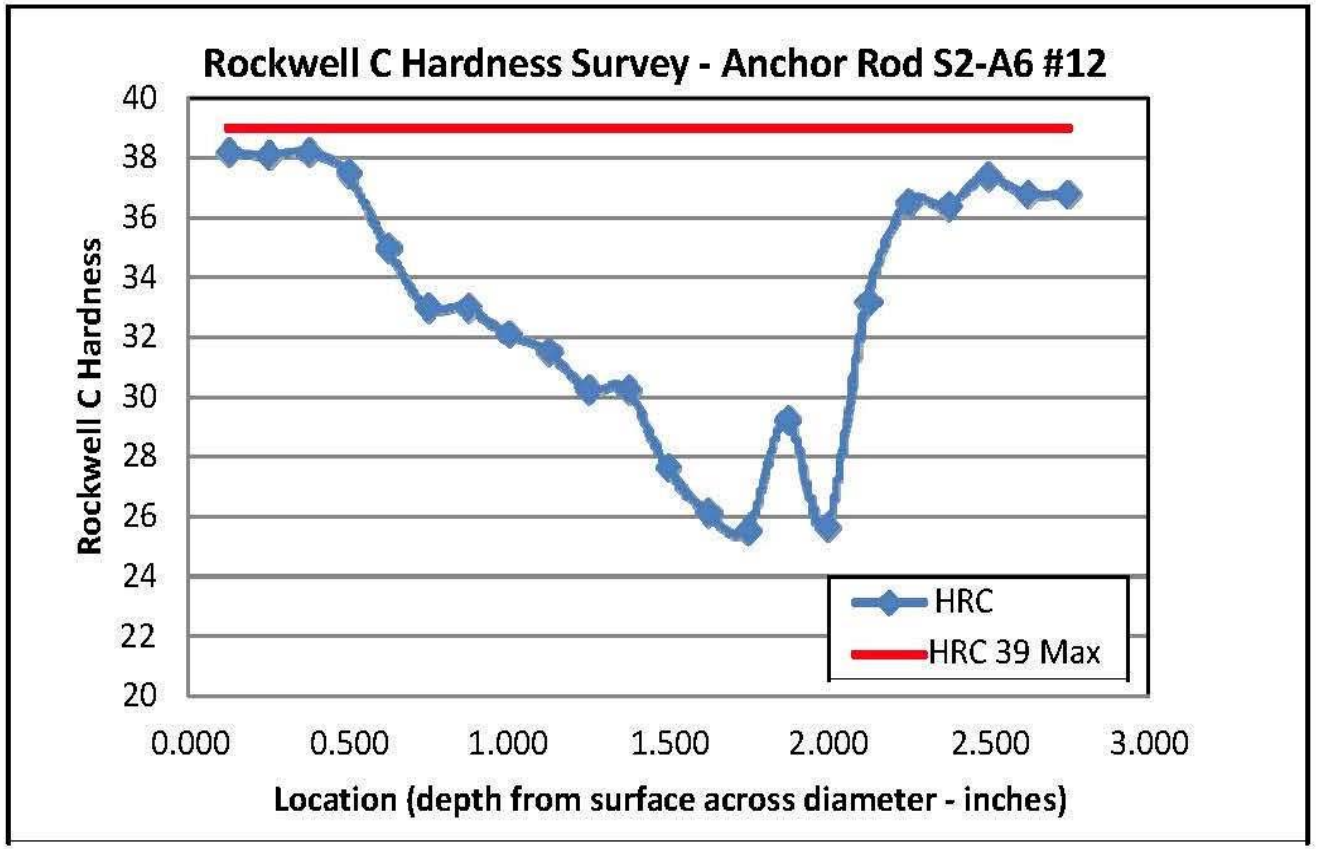
Item No.	Location	Component	Quantity Installed	Diameter (in)	Length (ft)	Tension (fraction of Fu*)
1	Top of Pier E2	Shear Key Anchor Rods (2008)	96	3	10-17	0.7
2		Bearing & Shear Key Anchor Rods	192	3	22-23	0.7
3		Shear Key Rods (top)	320	3	2-4.5	0.7
4		Bearing Rods (top)	224	2	4	0.7
5		Bearing Assembly	96	1	2.5	0.6
6		Bearing Retainer Ring Plate Assembly	336	1	0.2	0.4
7	Anchorage	Parallel Wire Strands (PWS) Anchor Rods	274	3.5	28-32	0.3
8	Top of Tower	Saddle Tie Rods	25	4	6-18	0.7
9		Saddle Turned Rods	108	3	1.5-2	0.5
10		Saddle Grillage	90	3	1	0.1
11		Outrigger Boom	4	3	2	0.1
12	Bottom of Tower	Tower Anchor Rods (Type 1)	388	3	26	0.5
13		Tower Anchor Rods (Type 2)	36	4	26	0.4
14	East Saddles	East Saddle Anchor Rods	32	2	3	0.1
15		East Saddle Tie Rods	18	3	5	0.1
16	East Cable	Cable Band Anchor Rod	24	3	10-11	0.2
17	Top of Pier W2	Bikepath Anchor Rods	43	1.2	1.5	TBD
		TOTAL QUANTITY	2,306			

Looking Back

Bearings and Shear Keys on Pier E2



2008 Rods Failed Due to Hydrogen Embrittlement



- Rods exhibited a material susceptibility to hydrogen embrittlement with a heterogenous structure and high surface hardness.

TBPOC Investigation of High Strength Steel Rods

- Conducted four half-day workshops and held 25+ other meetings or conference calls
- Reviewed over 5,000 pages of material
- Consulted with industry experts, Seismic Peer Review Panel, and FHWA team
- Briefed BATA and Bay Area State Legislators on multiple occasions

SAS Responsible Parties

- Caltrans is the Owner/Operator.
- TY Lin International/Moffatt & Nichol Design Joint Venture is the Engineer of Record.
- American Bridge/Fluor Joint Venture is the Contractor for the SAS Superstructure.

Findings – Owner, Designer, Contractor

- Per the joint metallurgical report, 2008 rods had "…higher than normal susceptibility of the steel to hydrogen embrittlement," but complied with specifications selected by the designer and owner of project

- Embedded rod design did not adequately address drainage, while contractor did not adequately provide on-site protection of 2008 rods from the environment during construction

Findings – Owner & Designer

- Failed to consider different uses and tension levels for high-strength rods on SAS
- Did not adequately evaluate alternative rod materials and procurement methods (i.e., sole sourcing)
- Did not account for combined effect of rod type selection and corrosion protection methods

Findings – Owner & Designer (con't)

- Failed to adequately consider corrosion protection alternatives to hot-dip galvanizing

- Relied too heavily on general ASTM guidance for contract specifications versus project-specific special provisions for steel hardness, toughness, and material testing

Findings – Owner & Contractor

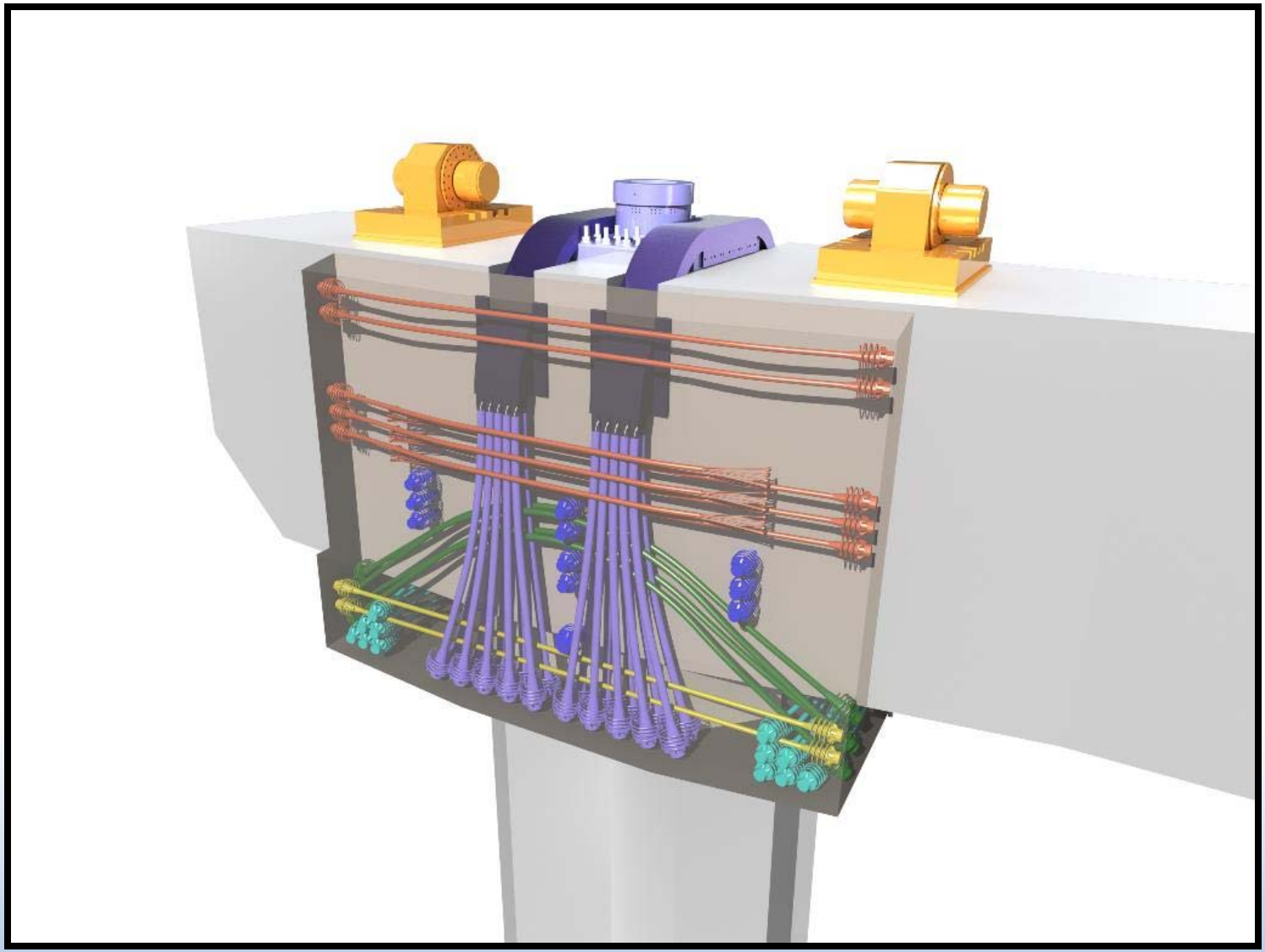
- Should have provided better coordination between the design and construction teams to ensure adequate material testing for hydrogen embrittlement.

Findings – Owner

- Failed to retain complete records in an easily retrievable format for new East Span contracts

Looking Forward

Rendering of Selected Steel Saddle Option



Status of Retrofit

- Fabrication on-going at XKT Engineering on Mare Island in Vallejo, CA and Steward Machine Co. in Birmingham, AL.
- Field preparation on-going with machining of shear key bases and concrete preparation of Pier E2 cap.

Retrofit Schedule & Bridge Opening

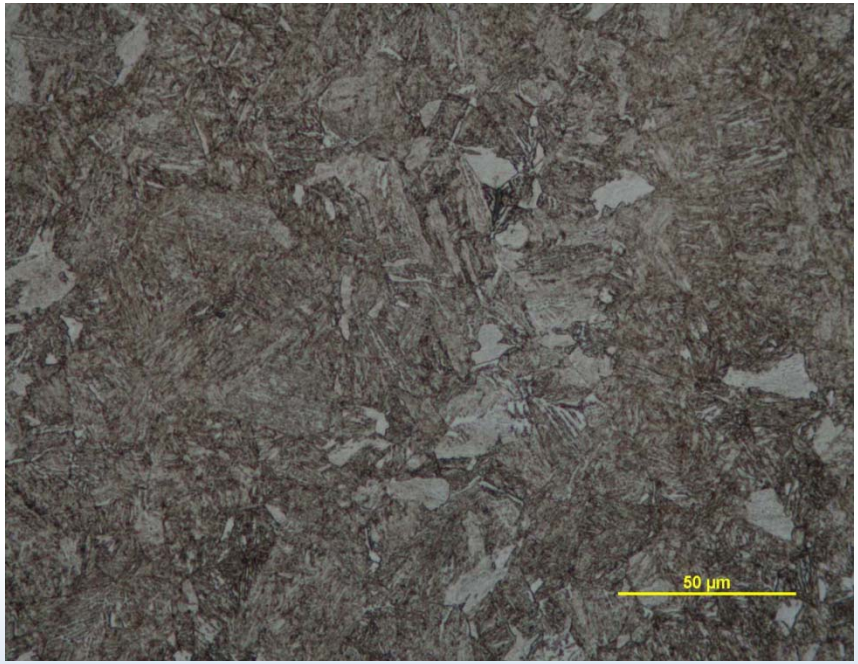
- Contractor forecasts shear key retrofit completion by December 10, 2013
- TBPOC will select bridge opening date based on retrofit completion, weather windows, and traffic impact
- Bridge opening may not coincide with Monday holiday weekend and will involve shorter advance notice

All Other Rods Performing As Designed Since Tensioning

Item #	Fabricator	End of Fabrication	Tension or Loading Complete	# of Rods Installed	# of Fractured Rods After Tensioning	Days Under Tension Through July 1, 2013
1	Dyson	Sep 2008	Mar 2013	96	32	Rods began failing after 3 days of tensioning
2	Dyson	Mar 2010	Apr 2013	192	0	91
3	Dyson	Mar 2010	Sep 2012	320	0	295
4	Dyson	Mar 2010	Sep 2012	224	0	292
5	Dyson	Aug 2009	Jun 2009	96	0	1,429
6	Dyson	Dec 2009	Jan 2010	336	0	1,245
7	Dyson	Nov 2011	Sep 2012	274	0	278
8	Dyson	Jul 2010	Jul 2012	25	0	351
9	Dyson	Jan 2011	Jul 2012	108	0	351
10	Dyson	Jan 2011	Mar 2013	90	0	97
11	Dyson	Oct 2011	Jul 2012	4	0	334
12	Vulcan Threaded Products	Feb 2007	Mar 2011	388	0	821
13	Vulcan Threaded Products	Feb 2007	Mar 2011	36	0	821
14	Dyson	Jun 2010	May 2010	32	0	1,125
15	Dyson	May 2010	Apr 2012	18	0	443
16	Dyson	Oct 2012	Feb 2013	24	0	142
17	Dyson	Jun 2009	In Design	43	0	-

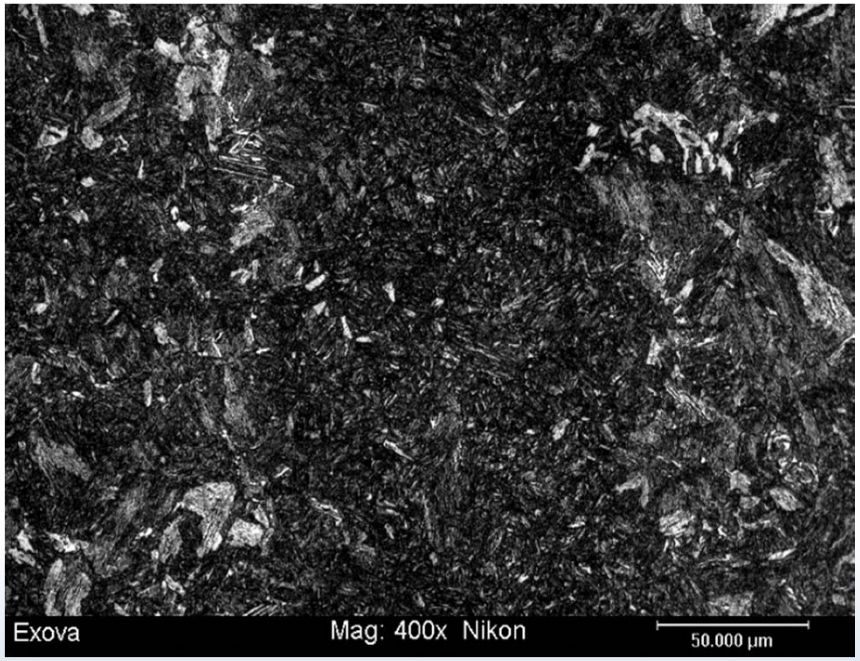
Improved Microstructure

Failed 2008 Rod



.
Structure is not fully tempered martensite. The center region did not fully transformed into martensite

Other Rod



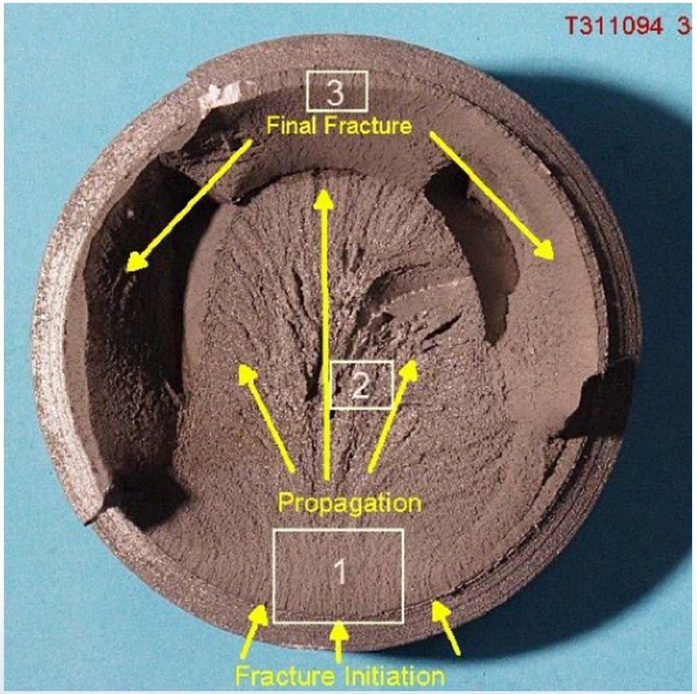
Essentially martensitic structure.

Improved Microstructure

Failed 2008 Rod

Brittle Failure in Field

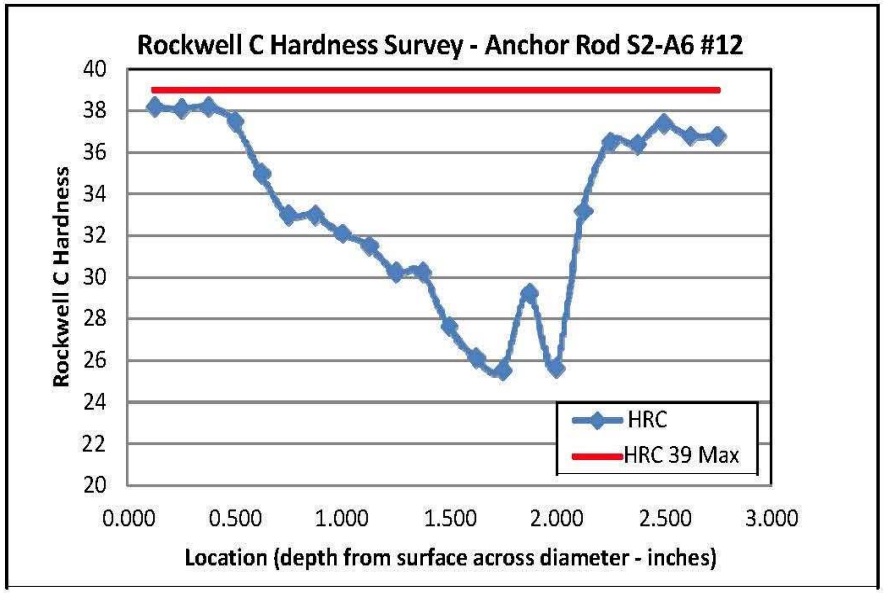
Other Rod



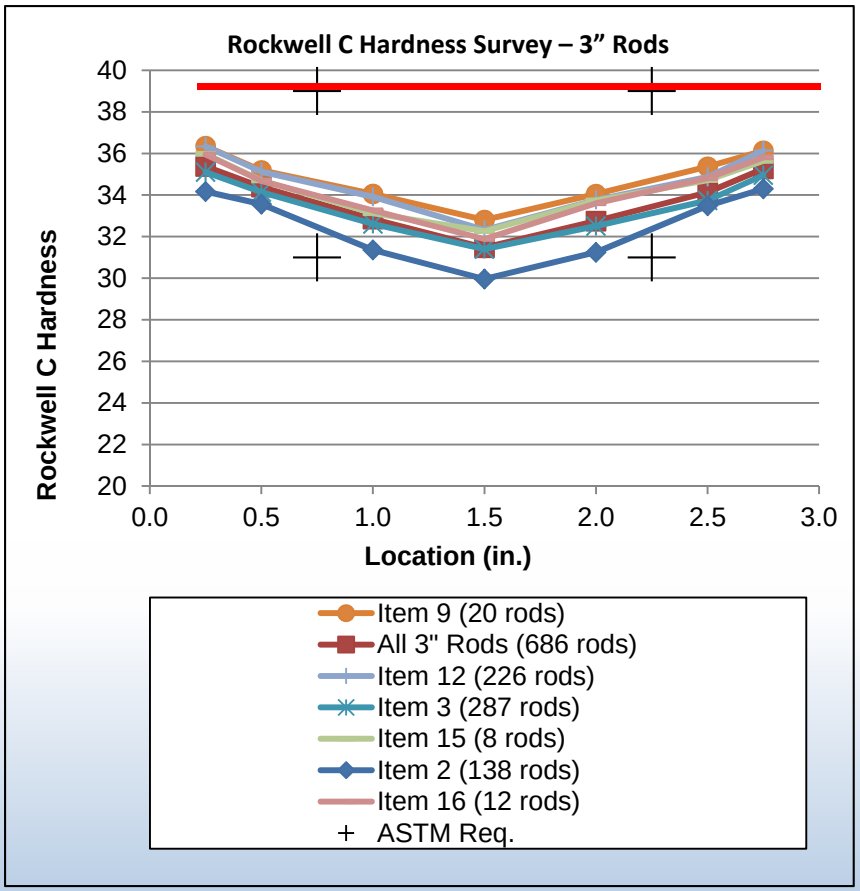
Ductile Failure in Lab Test

Improved Hardness

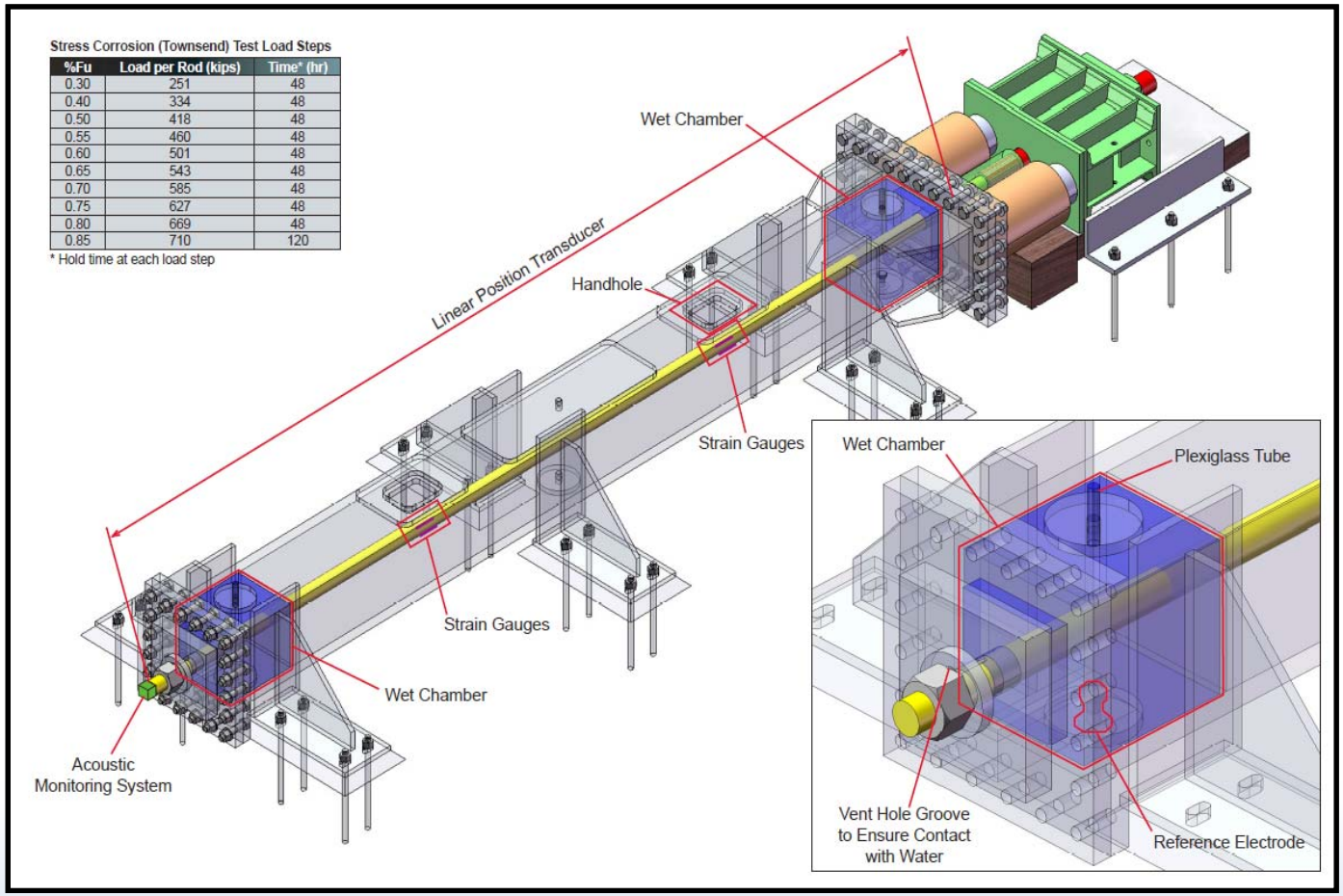
Failed 2008 Rod



Other 3” Rods

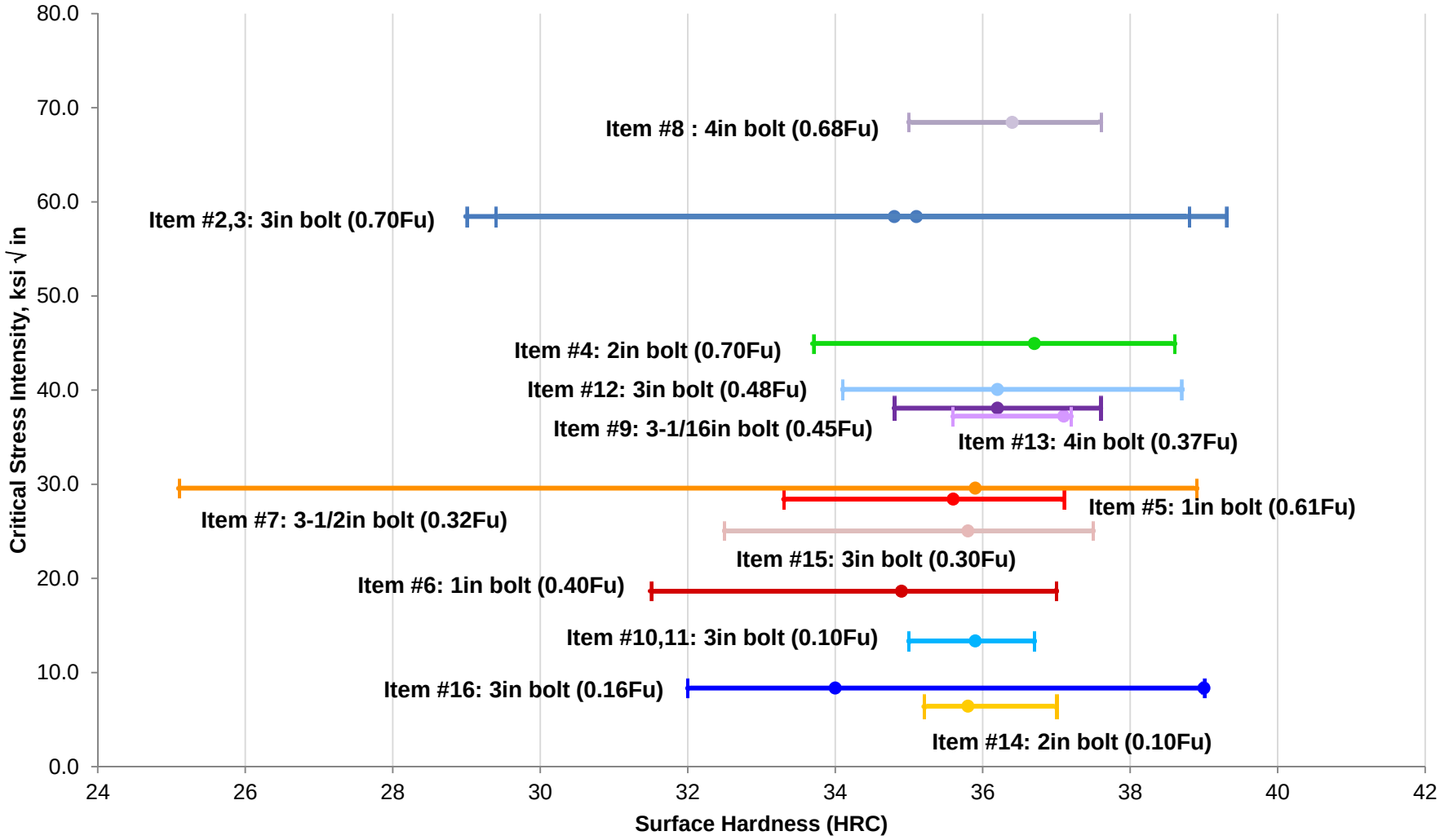


3D Rendering of Stress Corrosion Test Platform



- **Test platform being fabricated at Pier 7.**
- **First tests to begin the week of July 22, 2013**

Critical Stress Intensity vs. Surface Hardness
Townsend Formulation
(Based on Rod by Rod Data from Test 1: June 21, 2013)



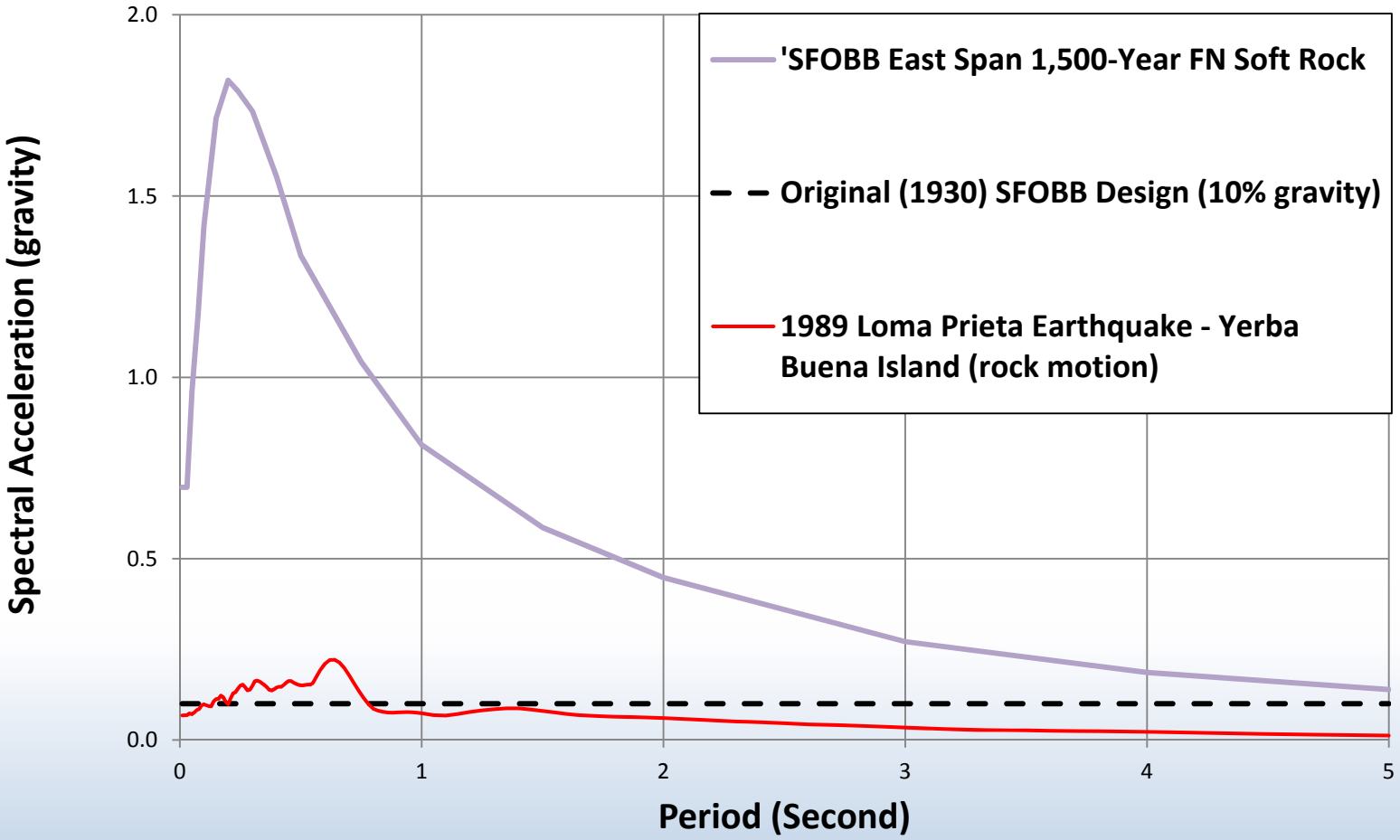
Rod By Rod Resolution (Provisional)

	Construction	Maintenance			
Location	**Replace Before Opening (96)**	**Replace After Opening (740)**	**Reduce Tension (557)**	**Augment Dehumidification (274)**	**Accept and Monitor (639)**
E2	1. Shear Key Anchor Rods (bottom) (96)* * replaced by steel saddle retrofit	2. Bearing & Shear Key Anchor Rods (bottom) (192) 3. Shear Key Rods (top) (320) 4. Bearing Rods (top) (224)			5. Bearing Assembly (96) 6. Bearing Retainer Ring Plate Assembly (336)
Anchorage				7. PWS Anchor Rods (274)	
Top of Tower		11. Outrigger Boom (4)	8. Saddle Tie Rods (25) 9. Saddle Turned Rods (108)		10. Saddle Grillage (90)
Bottom of Tower			12. Tower Anchor Rods (Type 1) (388) 13. Tower Anchor Rods (Type 2) (36)		
East Saddle					14. East Saddle Anchor Rods (32) 15. East Saddle Tie Rods (18)
East Cable					16. Cable Band Anchor Rod (24)
W2					17. Bikepath Anchor Rods – (43)

Note: Dehumidification is already in place for the Top of Tower, Bottom of Tower and Main Cable Anchorage.

New Bridge versus Old Bridge

Comparison of Ground Accelerations



Bottom Line

- It is safe to open the new East Span after replacing the capacity lost by the failed 2008 rods.
- The risk of near-term hydrogen embrittlement has passed.
- The potential for longer-term stress corrosion can be managed safely and effectively after SAS is placed into service.